

# **CERES Data Management System**

**October 1997**

**Lessons learned from TRMM simulations**

**Launch readiness: Instrument and ERBE-like subsystems**

**Schedules**

J.F.Kibler@LaRC.NASA.GOV  
Data Management Office  
Atmospheric Sciences Division  
NASA Langley Research Center

## **TRMM Mission Simulations**

**CERES and DAAC teams at Langley and TRMM and EOSDIS teams at GSFC conducted three end-to-end simulations: Sim #1 (11/96), Sim #2 (5/7-9/97), Sim #3 (6/11-13/97)**

- The TRMM satellite and instruments (located at the GSFC Integration and Test Facility) were commanded through almost all operational modes from the TRMM Mission Operations Center (MOC) using TDRSS links.**
- Both real-time housekeeping and science telemetry data from CERES were transmitted from the TRMM satellite through TDRSS to the PACOR Level 0 processing facility at GSFC.**
- Real-time displays and data files from the MOC were transmitted through secure NASCOM lines to the CERES Instrument Support Workstation in ASD.**
- After initial processing at PACOR, the Level 0 science data stream was transmitted to the LaRC DAAC, both as quick-look and 24-hour data files, and captured using EOSDIS ingest system.**
- Flight Dynamics Facility at GSFC produced spacecraft ephemeris data used by MOC to generate planning aids for scheduling instrument commands and evaluation on CERES ISW.**
- Data Distribution Facility at GSFC transmitted ephemeris files to LaRC DAAC where they were processed through DPREP to produce toolkit-compatible files.**
- For Sims #1 and #2, Science Data was processed at SCF for evaluation.**
- For Sim #3, Science Data was processed at the DAAC by DAAC personnel in a realistic scenario.**
- CERES personnel evaluated the level-1 science products using SCF tools.**

**Also conducted a series of 30-day tests (August-October) using replay data from the simulations.**

- Level 0 instrument and ephemeris data files transmitted from PACOR to DAAC**
- Produced Level 1 science products from Instrument Subsystem**
- Realistic test of network, procedures, and processing loads**

## **Specific CERES Operations**

**Each test was carried out over a three-day period with all clocks, including the spacecraft clock, synchronized to the same time.**

**CERES team prepared an operational plan for each test. Command activities for tests included:**

- Baseline science operation which simulated a 3-day operational cycle of the instrument in the cross-track and biaxial scan modes.**
- Solar and internal calibrations.**
- Data generated with all CERES APID's and data packet formats.**

**Special activities were carried out as follows:**

- Main contamination covers were opened and closed during Sim#2.**
- Deep Space Calibration Maneuver was simulated during Sim#3.**

## **Lessons learned: Operational data interfaces**

The analysis on which these items are based was possible because of access to planning aid data, operational reports, and real instrument housekeeping data.

- Found that CERES ISW [equivalent of EOS IST] does not automatically configure to receive real-time housekeeping data displays, as originally documented.
  - LaRC personnel must log into MOC software for each real-time event.
  - Logins are not always successful because of problems at the MOC.
- Post-contact delivery of housekeeping data files [called snap files by TRMM] is not performed automatically, as originally documented.
  - Requires initiation by TRMM MOC personnel.
- Comparison of data in the science and housekeeping data streams:
  - Helped verify conversion algorithms and discover errors.
  - Errors were corrected in the TRMM MOC database.
- Analysis of planning aid data verified the planning algorithms, in general.
  - A few discrepancies were discovered resolved with MOC and FDF personnel.
- Comparison of command scheduling [using time-line report] against actual planning aid data helped uncover some glitches in TRMM scheduling methods.

# Real-time display captured on Langley ISW from TRMM simulation

CERESHK2 - TRMM - Mission Operations Center - Front End TR2FE1 (Display only)

\*\*\* CERES HOUSEKEEPING II (cereshk2) \*\*\*

GMT TIME: 97-130-14:05:04.933    PKT CNT: 2540    [Related Pages](#)

S/C TIME: 97-130-14:03:38.570    PKT TIME: 97-130-14:01:39.357

DETECTOR DATA			
	TOTAL	SHORTWAVE	LONGWAVE
Sample # 1:	14	11	6
Sample # 2:	14	10	5
Sample # 3:	16	10	5
Sample # 4:	13	10	5
Sample # 5:	14	10	5

Meas Temp:	37.886 DEG	37.89 DEG	37.89 DEG
Control Temp:	37.856 DEG	37.575 DEG	37.19 DEG
Temp Set Point:	2048.00	2048.00	2048.00
Temp Control:	ON	ON	ON
Heater DAC:	778 CNT	733 CNT	631 CNT

Space Look:	245 CNT	175 CNT	94 CNT
Bridge Balance:	MAINTENANCE	MAINTENANCE	MAINTENANCE
Reset Counter:	0.00	0.00	0.00
DAC Update Status:	HOLDING	HOLDING	HOLDING
Coarse DAC Value:	2271 CNT	2111 CNT	2063 CNT
Fine DAC Value:	2585 CNT	1999 CNT	1604 CNT

IPSDU A   Pwr / I:	ON	0.59
IPSDU B   Pwr / I:	OFF	0.67

PSIB A   V / I:	31.29	15.01
PSIB B   V / I:	NoDataNoData	NoDataNoData

BLACK BODY	
Blackbody Temp Control:	ON
Total Blackbody Temp:	31.8163 DEG
Blackbody Temp Setpoint:	2650.0000
Blackbody Heater DAC:	0 CNT

SWICS	
Intensity Command:	OFF
Lamp Current:	0.000
Photodiode Output:	0 CNT
Photodiode Temp:	33.079 DEG

INSTRUMENT INFO	
Inst. Packet Type	SCIENCE
Instrument Mode	INT_CAL
Azimuth Mode	CROSS-TRACK
Elevation Mode	NORMAL

TEMPERATURE DATA	
Sensor Module	35.327 DEG
SEA Electronics	40.752 DEG
Cable Spindle	34.722 DEG
Cable Bearing	33.079 DEG
Motor Spindle	34.722 DEG
Motor Bearing	33.079 DEG
ECA Radiator	31.983 DEG
ECA Electronics	34.227 DEG
DAA Radiator	33.552 DEG
DAA CPU	34.821 DEG
DAA ADC	48.077 DEG
Az Lower Bearing	30.934 DEG
Az Upper Bearing	31.983 DEG
Brake Housing	28.953 DEG
ACA Electronics	30.934 DEG
ICA Radiator	28.953 DEG
ICA CPU	32.525 DEG
ICA ADC	41.756 DEG
Pedestal Isolator	28.479 DEG
DCA Radiator	31.453 DEG
PCA Radiator	31.983 DEG

AZIMUTH BRAKE DATA	
Command Status	RELEASE
Motion Status	STOPPED
Position Status	RELEASED

## **Lessons learned: Ephemeris, Level-0, and Quick-Look data interfaces**

- **Discovered that ephemeris and level-0 spacecraft housekeeping data must be preprocessed to generate ephemeris and spacecraft attitude data compatible with toolkit provided by ECS.**
  - **Toolkit troops at Hughes knew about this, but those of us in the hinterlands didn't get the message.**
  - **LARC DAAC personnel obtained the preprocessing software [DPREP] from the Hughes and worked closely with CERES and Hughes personnel to make the procedures for executing this software routinely operational at the DAAC.**
- **CERES personnel worked with SDPF personnel to establish procedures for requesting and processing quick-look data files.**
- **LaRC DAAC used data from these tests to perform initial evaluation of its ingest software and hardware in a realistic mission environment.**
- **Corrected TRMM definition of beta angle (between orbit plane and sun) to match documented definition.**

## **Lessons learned: Science data processing system**

**These lessons were only possible because of access to real CERES instrument data.**

- **CERES Project exercised level-0 processing software, validation/visualization software, and analytical procedures which will be used to process and validate actual flight data.**
  - **Although most of the radiometric data were obtained while the instrument scanned inside the contamination covers, the data show performance characteristics of the actual sensors, not simulated characteristics.**
- **The actual format of CERES data packets was different from that shown in TRW documentation. A minor point, perhaps, but it would have taken a week or more after launch to fix the byte-reversal and formatting problems.**
- **Found geolocation algorithms were not correctly handling mode transitions**
  - **Occurred at shifts from full cross-track to rotating azimuth mode.**
  - **Easy problem to fix once it is discovered, but without our actual instrument data, impossible to find.**
- **Discovered that CERES software was mishandling DAC updates, which cause a shift in the space clamp (essentially a calibration on every scan). Problem is now fixed, again saving time after launch.**
- **Level 1 products showed an intermittent problem with the elevation gimbal, an apparent jump about once or twice an hour.**
  - **Turned out to be a 0.01 second data dropout from the onboard processors.**
  - **TRW fixed the flight code with a memory patch after Sim #3.**
  - **If this anomaly had not been found, measurements would have been incorrectly geolocated in the effected scans.**

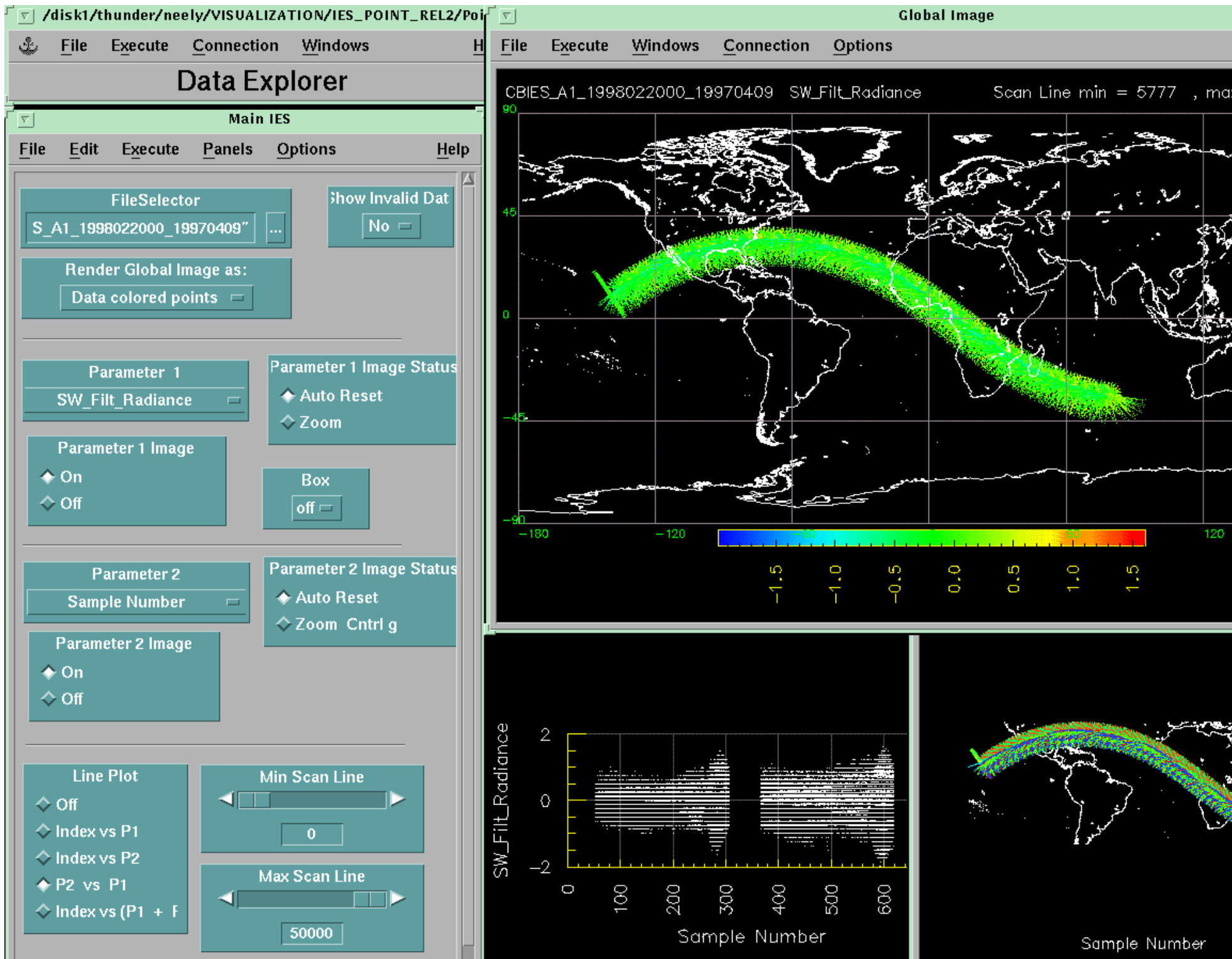
## **Lessons learned: Science data processing system**

- **During the period when the contamination covers were open, the instrument scanned a light bulb (poor man's point-spread-function test!)**
  - **Helped pin down the time delay in the sensors and electronics all the way through the satellite data system.**
  - **These delays had been measured in the calibration chamber at TRW, but not with the system integrated as a whole.**
  - **Again, essential for accurate geolocation.**
- **Found that CERES instrument sometimes rejected stored commands**
  - **Analyzed command history log generated by science data processing system.**
  - **Problem traced to violations of operational constraints in command scheduling procedures at the MOC.**

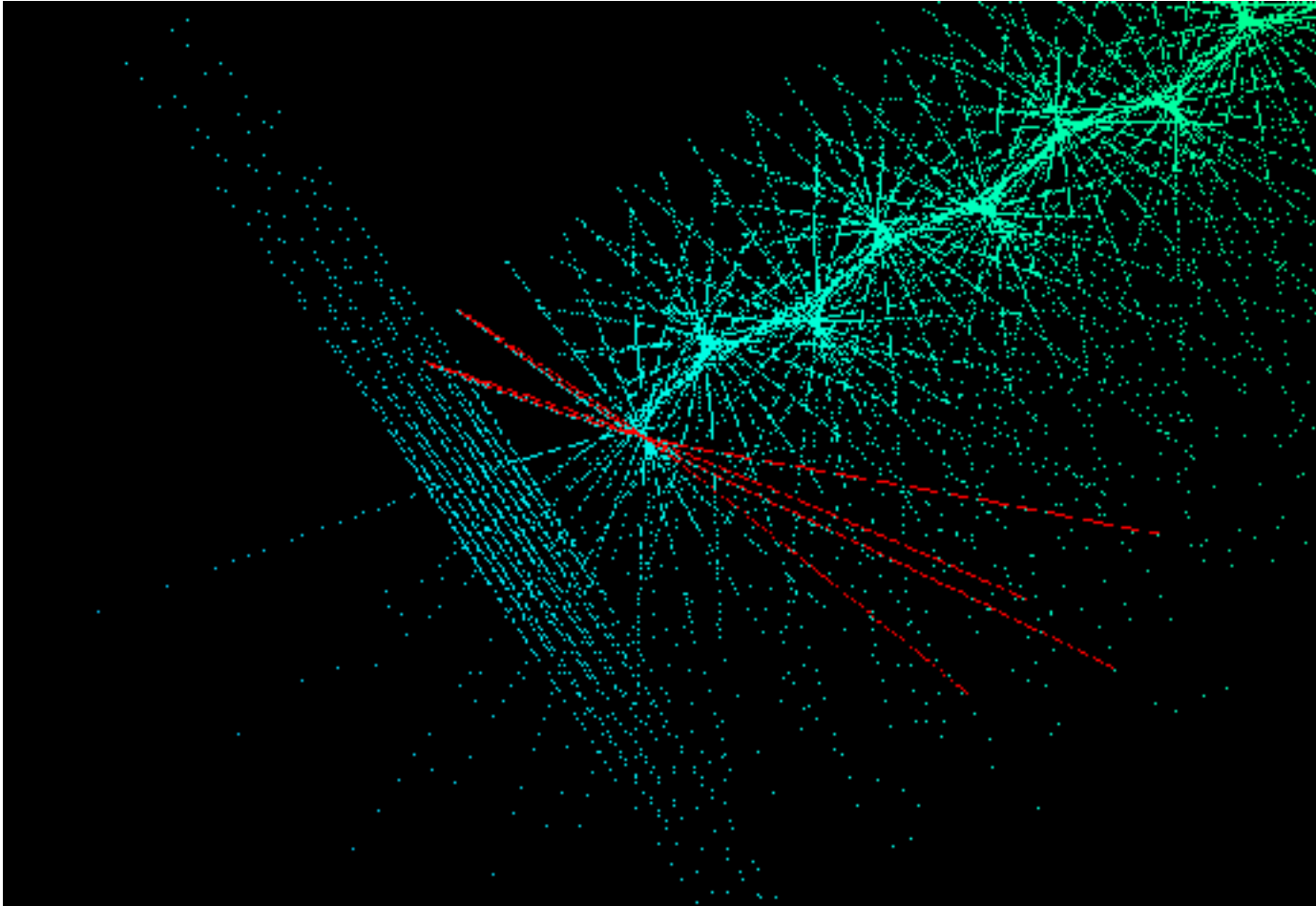
**Perhaps the most important aspect of the tests was the experience and knowledge gained from this first-time interaction among the various organizations required to make the TRMM and CERES missions successful.**

**Overall, the CERES Project is much better prepared for the launch of the first CERES instrument than was the case for the first ERBE launch, due in no small part to these TRMM simulations. [End-to-end simulations were not performed before the ERBE launches]**





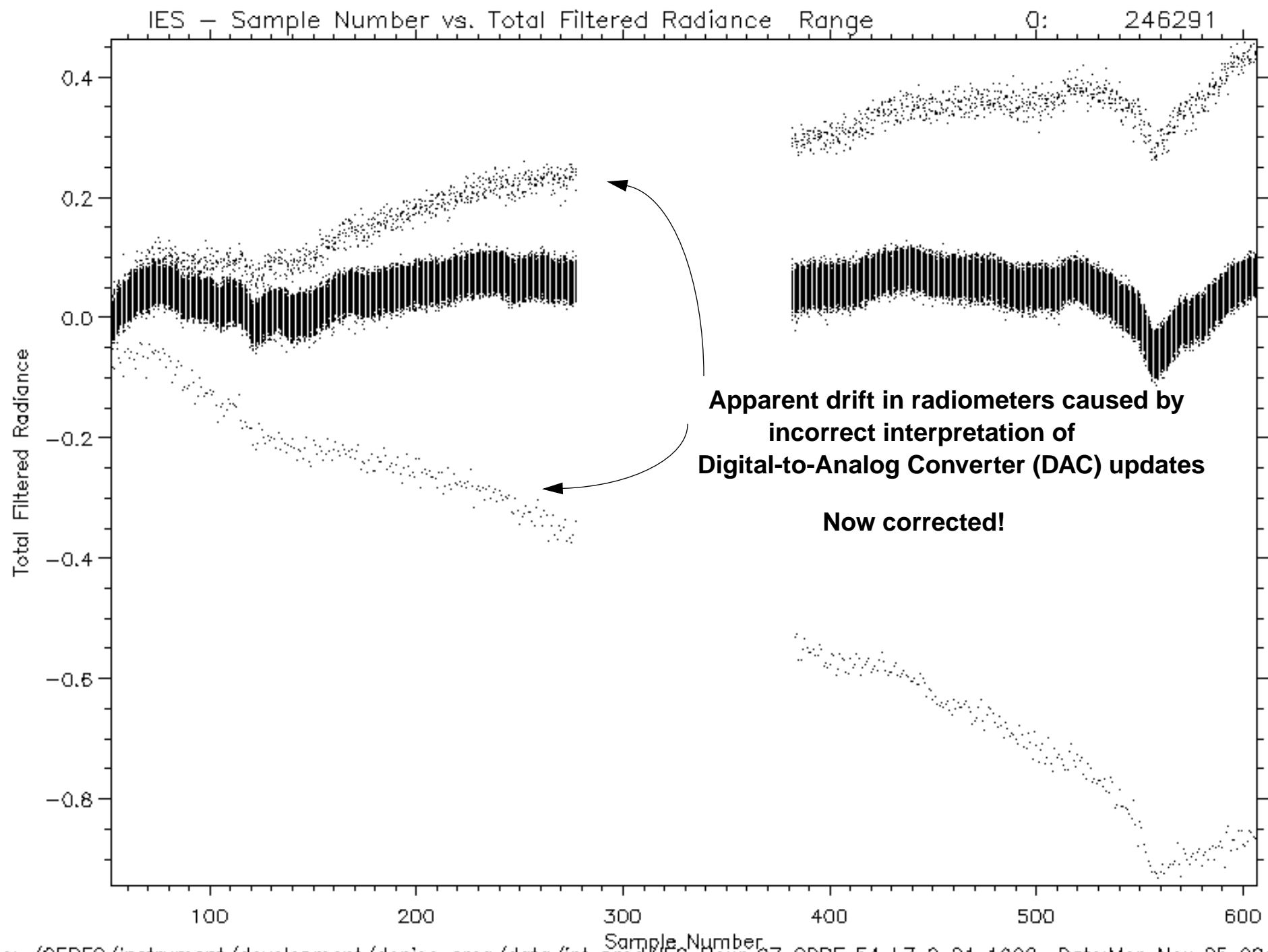
**BDS Release 2 Visualization - FAPS Normal Scan to RAPS Short Scan**  
**File: CBDS\_A1\_54\_19980220\_19970317**



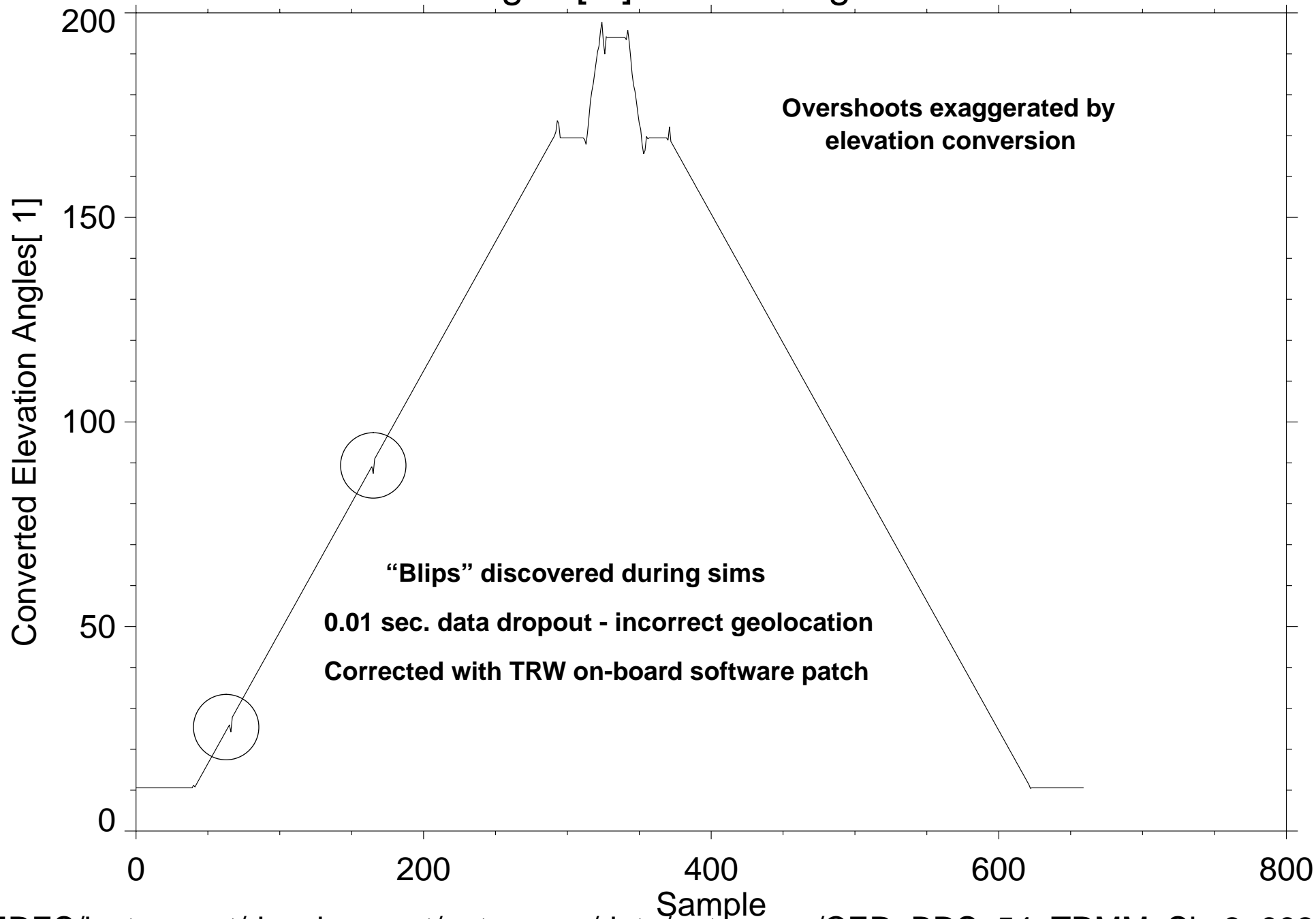
**Transition from cross-track to RAPS mode caused geometry errors detected by visualization - now corrected**

**Data from CERES PFM instrument during TRMM Mission Simulation #1 - November 1996**

## Multiple scans of contamination covers



Converted Elevation Angles[ 1] Data Range: 1636: 1637: 1 0: 660: 1



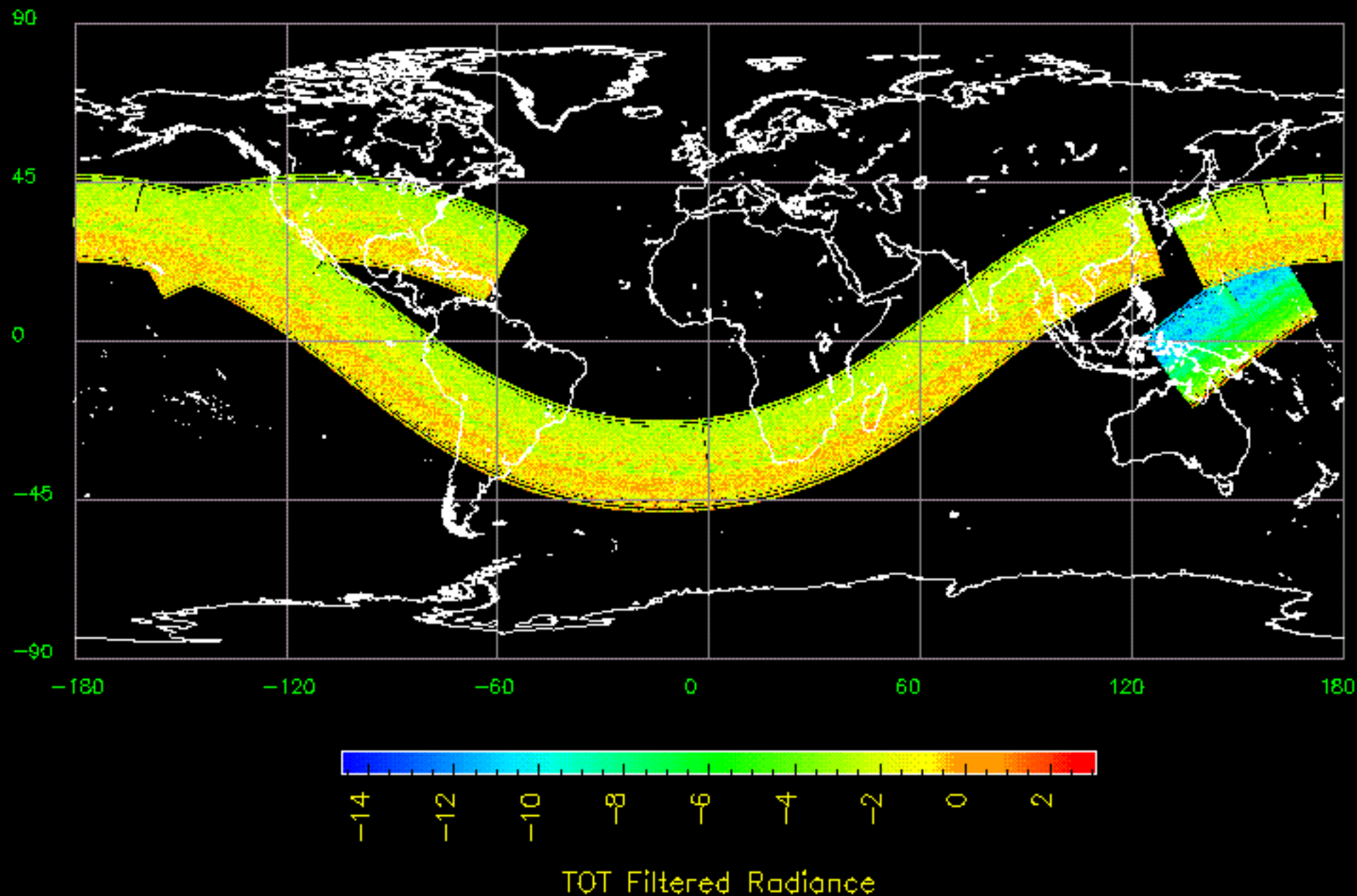
## TRMM Sim #3 - Processed within hours of data acquisition

CER\_BDS\_54\_TRMM\_Sim3\_008.19970611

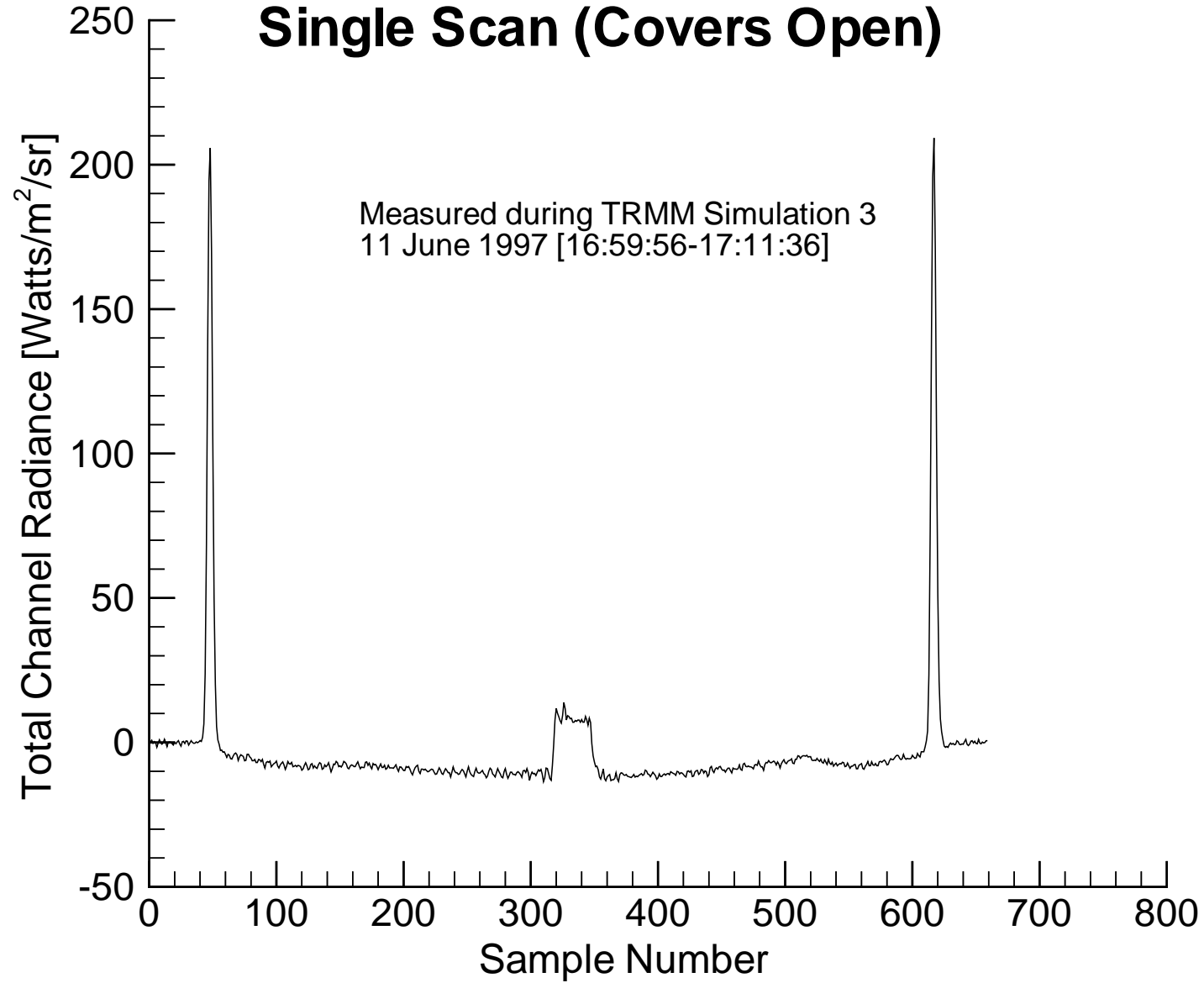
Max scan line = 6302

Max width = 659

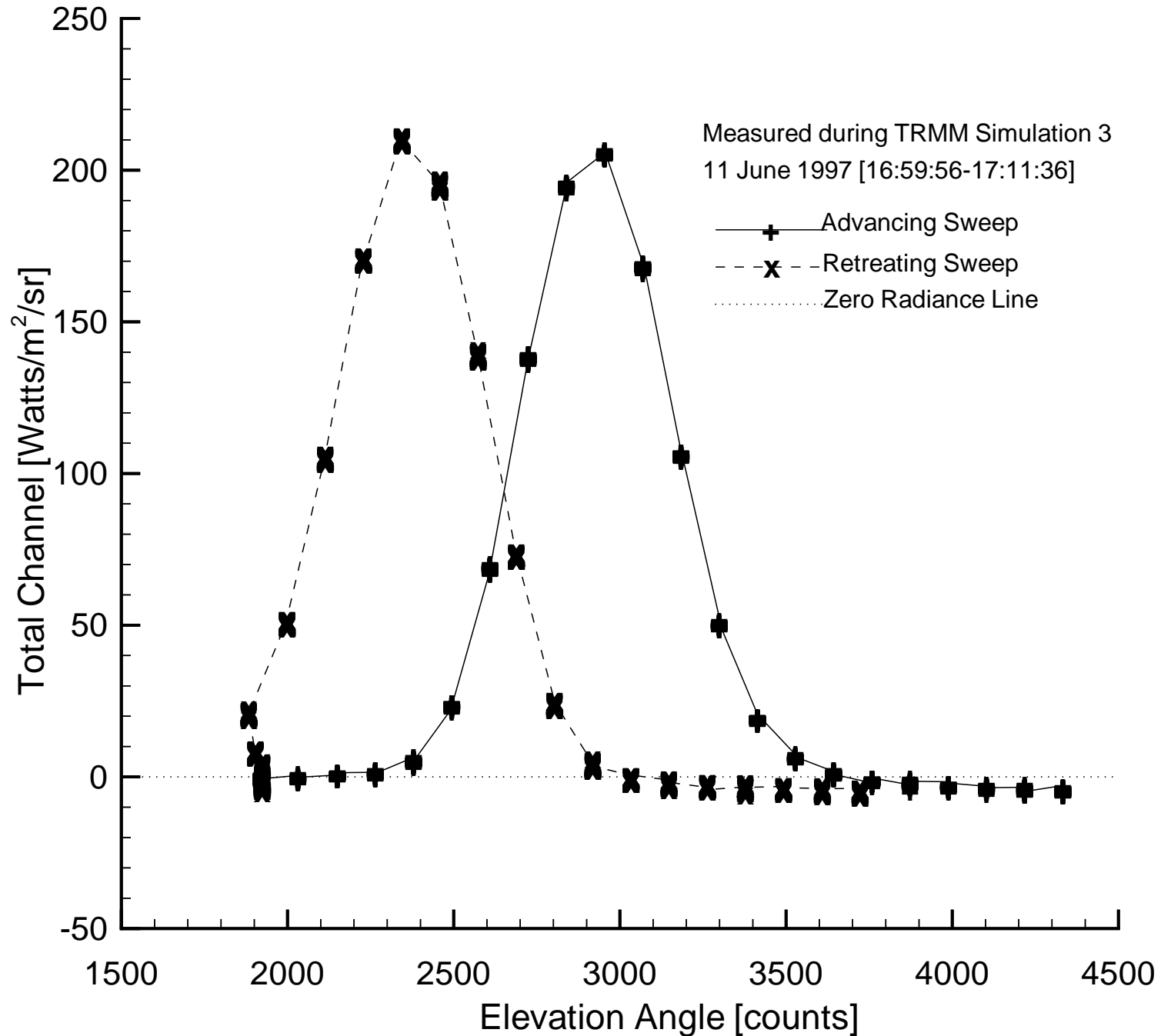
Thu Sep 4 07:54:40 1997



## Single Scan (Covers Open)



# Measured Radiance - Total Channel



## **Working Group: Instrument**

### **Responsible for:**

- **Subsystem 1 (Instrument Geolocate and Calibrate Earth Radiances)**

### **Data Products:**

- **BDS (Bi-Directional Scan)**
- **IES (Instrument Earth Scan)**

### **Current Status:**

- **Release 2 system architecture implemented; testing and verification underway**
- **Additional system QC and analysis reports being designed and implemented**
- **Processed data from TRMM Simulation #2 (6/97), #3 (7/97), and 30-day (8/18-9/18/97)**
  - **Subsystem delivered to the DAAC and run by DAAC personnel**
- **Developing graphical analysis tools using IDL**
- **Re-delivered Subsystem code updates to DAAC during 2nd week of TRMM 30-day test to exercise SSI&T during normal operations**

### **Near-term Plans:**

- **Continue verification of system functionality and output products**
- **Support DAAC during the TRMM 30-day test**
- **Complete metadata to be compliant with new Toolkit version**
- **Deliver flight ready system to DAAC for TRMM launch**
- **Prepare to analyze IES and BDS during early-orbit check-out after TRMM launch**
- **Implement support for EOS platforms**



# **Working Group: ERBE-like**

## **Responsible for:**

- **Subsystem 2 (ERBE-like Inversion to Instantaneous TOA Fluxes)**
- **Subsystem 3 (ERBE-like Averaging to Monthly TOA Fluxes)**

## **Data Products:**

- **ES-8 (Equivalent to ERBE Instantaneous TOA Estimates)**
- **ES-9 (Monthly Averaged Regional Parameters)**
- **ES-4, ES-4G (Monthly Averaged Regional, Zonal, Global Parameters by region and gridded)**
- **Scene ID Ancillary Input Data, Spectral Correction Ancillary Input Data**
- **Solar Declination values for each year, Albedo Directional Model values**
- **ES-8 and ES-4 Browse Products**

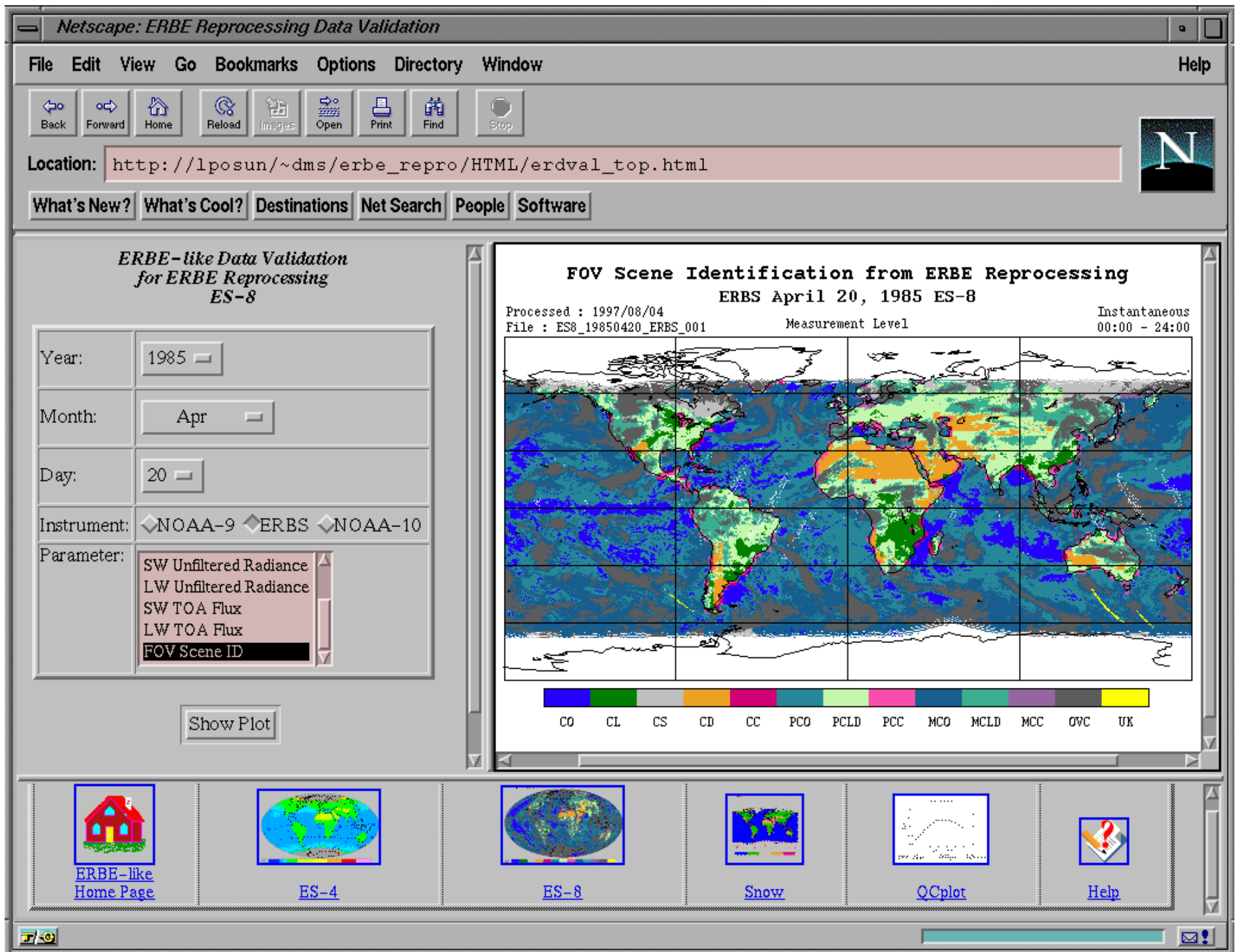
## **Current Status:**

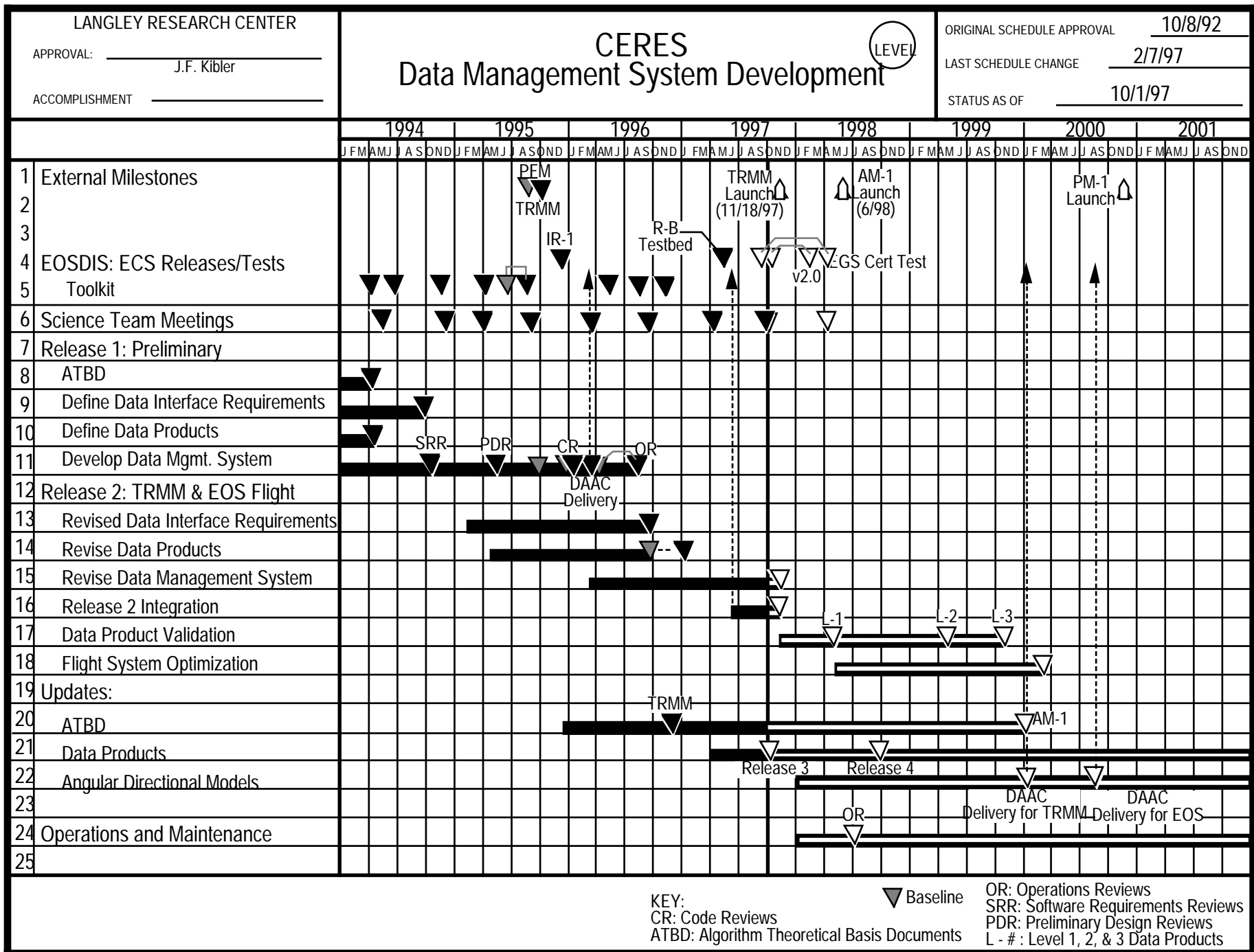
- **ES-8 includes all 660 measurements per record, not just the 450 Earth-viewing measurements.**
- **New radiance pair SW and LW ADMs (includes colatitudinal and seasonal dependency)**
- **Began ERBE Scanner Data Reprocessing at the DAAC**
  - **New snow maps (northern hemisphere is from original ERBE and southern hemisphere is from SMMR & SSM/I data sets)**
  - **New NOAA-9 offsets to address the 2% SW channel (calibration) problem**
  - **New monthly spectral correction coefficients to address the 1% ERBS drift problem**
  - **New tropical constant and 3-channel intercomparison algorithms added to QC report**
  - **New directional models**
  - **Added scripts to generate ES-8 and ES-4 browse images available on the Web**
  - **Can now process one year of ERBE data in less than one day**

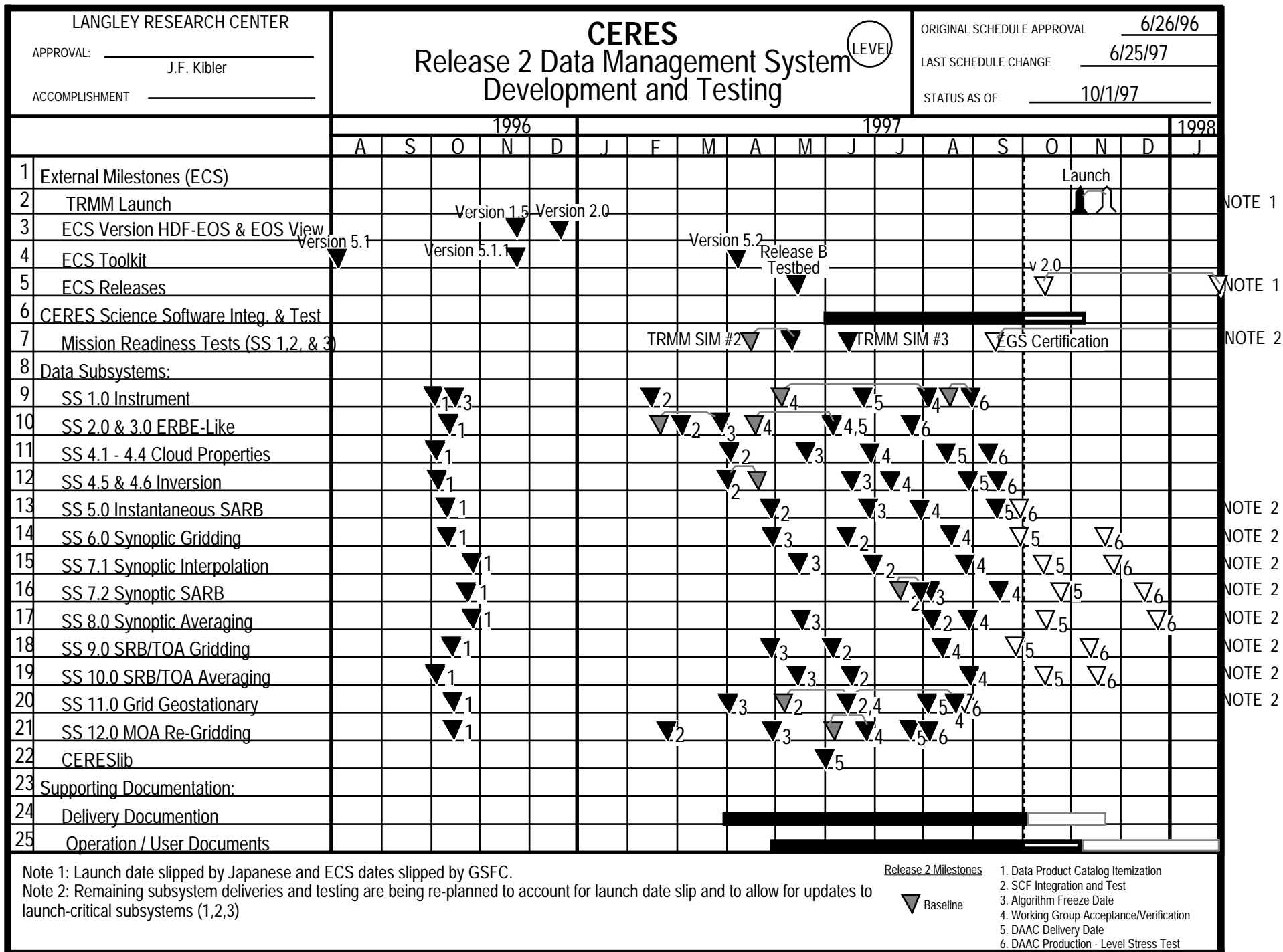
## **Near-term Plans:**

- **Complete the ERBE Scanner Data Reprocessing.**
- **Support the TRMM “30-day test” based on Sim #3 data.**
- **Complete implementation of metadata into all products in HDF format.**
- **Provide final software to the Langley DAAC for TRMM processing.**

# QC plots available on web as ERBE-like processing is completed







## Near-term CERES Operational Milestones - TRMM Launch 11/18/97

<u>Date</u>	<u>Activity</u>	<u>Operational Subsystems</u>
11/25/97	After power-on (11/23), 1st covers-on real data	Instrument
11/25-12/27	Instrument testing/diagnostics/internal calcs Dry run of deep-space offset determination	Instrument (ERBE-like tests) Off-line SCF procedures
12/19	Data available after covers open (12/18)	Instrument, ERBE-like (daily)
12/19-12/28	Internal calcs, Solar calcs Determine in-orbit calibration coefficients	Instrument Off-line SCF procedures
12/29	Data available from 1st deep-space (12/28) Derive elevation-dependent offsets in one day	Instrument Off-line SCF procedures
1/5-9/98	Evaluation with revised coefficients/offsets	Instrument, ERBE-like (daily)
Mid Jan	Send sample ES-8's w/ doc, read s/w to Science Team Partial month of 12/97 ES-9, ES-4 with December snow?	ERBE-like (daily&monthly) (Others test)
Mid Feb	MOA, VIRS (?), real snow - Produce ES-9, ES-4 for 1/98 Produce sample SSF's, CRS's for local evaluation Send sample SSF's, CRS's w/ doc, read s/w to Science Team	ERBE-like, Clouds Inversion, SARB (TISA tests)
Mid March	Send sample monthly products for 1/98 w/ doc, read s/w	TISA